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WATER POLLUTION CAUSED BY THE OPERATION OF VESSELS

Federal Water Pollution Control Administration
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A Report on

WATER POLLUTION CAUSED BY THE OPERATION OF VESSELS

. . . prepared in
consultation with

...the Secretary of Defense
...the Secretary of the Treasury
...the Secretary of Commerce
...the Secretary of Health,
Education, and Welfare

UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

December 1966

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FOREWORD

The Prevention, Control, and Abatement of Water Pollution by Federal Activities was the subject of Executive Order 11288 signed by the President July 2, 1966. This report is a follow-through on Section 8 of the Order here quoted:

> "The Secretary of the Interior shall make a comprehensive study of the problem of water pollution within the United States caused by the operation of vessels, and shall develop such recommendations for corrective or preventive action as may be appropriate, including recommendations with respect to vessels operated by any department, agency, or establishment of the Federal Government. The results of the study and recommendations shall be transmitted to the President by January 1, 1967. The study and report thereon shall be prepared in consultation with, and with the advice and assistance of, the Secretary of Defense, the Secretary of the Treasury, the Secretary of Commerce, and the Secretary of Health, Education, and Welfare."

Another report on pollution emanating from watercraft is required in the Clean Water Restoration Act of 1966 (P. L. 89-753) amending the Federal Water Pollution Control Act. Section 17 thereof is as follows:

> "The Secretary of the Interior shall, in consultation with the Secretary of the Army, the Secretary of the department in which the Coast Guard is operating, the Secretary of Health, Education, and Welfare, and the Secretary of Commerce, conduct a full and complete investigation and study of the extent of the pollution of all navigable waters of the United States from litter and sewage discharged, dumped, or otherwise deposited into such waters from watercraft using such waters, and methods of abating either in whole or in part such pollution. The Secretary shall submit a report of such investigation to Congress, together with his recommendations for any necessary legislation, not later than July 1, 1967."

Together these two reports will provide a basis for developing remedial action programs and recommendations for legislation needed to abate and prevent water pollution from vessels and watercraft operating in U. S. waters.

SUMMARY

From border to border and coast to coast, the waters of our Nation are being degraded by untreated and inadequately treated wastes of many kinds. Increasing amounts of such wastes are discharged from the ever growing number of watercraft which ply our waters, both inland and coastal. Vessels and boats may discharge into such critical areas as those used for body-contact water sports, potable water supply intakes, and shellfish beds, or into lakes where the vessel wastes join with those from other sources to speed up the process of eutrophication.

Even though the people aboard vessels in waters of the United States average less than 1 percent of our total national population, the pollution hazard to human health and esthetics from this source is substantial. It is accentuated and control made more difficult because vessel pollution is transient and variously distributed, changing locale and degree of concentration from day to day as watercraft, large and small, trave from place to place.

As part of the national water pollution control effort, we must find ways and means of controlling and eliminating this type of pollution. To efficiently approach the task, we must set forth the magnitude of the problem and then proceed to apply the available technology. This report delineates the former and makes recommendations for its control under the latter.

Water pollution from the source here reported may include the wastes discharged from 46,000 documented American flag vessels, 65,000 non-documented commercial fishing vessels, 40,000 foreign ships which annually enter U.S. waters, 1,500 Federal vessels, and 8,000,000 recreational watercraft of which 1,290,000 have toilet facilities.

The pollutants which they discharge, and which degrade the waters at and around the point of disposal, include sewage, oils, chemicals, and other wastes, not infrequently involving accidental spills of valuable cargoes.

Most vessels are not equipped to give even minimal treatment to sewage and other wastes.

The uncertainty of discharges as to number, time, place, and frequency adds to the hazard and the control problem.

While 28 States have passed laws regulating vessel discharges, these are generally directed only toward sewage discharges from recreational watercraft. While no specific study of State enforcement has been made, it is known that many of the 28 lack the necessary mechanism to efficiently regulate sewage discharges from the many small watercraft involved.

Federal laws and regulations (Exhibit 6) prohibit dumping of litter and certain garbage items, oil, sewage, and waste waters in specific locations. As these statutes and regulations are primarily intended to prevent the impairment of navigation and the spread of animal diseases or plant pests, they are not always effective in preventing water pollution from vessels. Water quality standards to be established in accordance with the Water Quality Act of 1965 may restrict the discharge of pollutants from vessels. Also, the Clean Water Restoration Act of 1966 placed with the Secretary of the Interior the administrative responsibility for the Oil Pollution Act of 1924. The Act now includes oil from any source discharged to any navigable waters of the United States. This gives increased opportunity for the control of oil as a pollutant in both inland and coastal waters.

On-board holding tanks, in combination with suitable shoreside (or high seas) discharge, could eliminate much of the pollution from vessels, but shoreside facilities are not generally available. The technology does exist for adequate shoreside disposal and treatment which generally could employ the same methods used in municipal sewage treatment plants. In many instances, shoreside facilities receiving vessel wastes could feasibly discharge to municipal sewerage systems.

On-board equipment for properly treating vessel wastes before discharge is not fully developed to meet all present needs. Maceration and chlorination units for small watercraft have proved desirable and worthwhile for interim use until shoreside facilities are available or other entirely adequate technology is developed. Generally, however, on-board sewage treatment units are bulky and heavy, or only minimally effective.

Further research, development, testing and evaluation (RDT&E) are urgently needed to deal more effectively with the less difficult problems and to find adequate solutions to problems which stress the limits of present technology. Federal activities in these areas should be expanded and FWPCA is the suggested logical agency to lead and coordinate these activities.

Federal expenditures for vessel pollution control programs, including RDT&E, are modest. Total RDT&E funds for all Federal agencies amounts to $1,087,000 in FY 1967 and action programs by these agencies are budgeted at only $1,017,000. This level of effort must be greatly elevated to meet water pollution control needs of Federal vessels.

RECOMMENDATIONS

To assure effective control of pollution from the operation of vessels, it is recommended that:

1. Action be taken to control pollution from existing vessels to the maximum extent possible under present laws and regulations and up to the limits of existing technology. The installation of appropriate water pollution control systems on new vessels should be required.

Such action can be implemented through revisions in Maritime Administration requirements for new vessel construction, revisions in the U.S. Coast Guard safety regulations, revisions in the Interstate Quarantine Regulations and Foreign Quarantine Regulations: accelerated enforcement of the now more definitive discharge requirements under the Oil Pollution Act; and revision of other Federal and State programs which may influence the installation of pollution control equipment on board vessels or in ports, harbors, and marinas.

2, Development, installation, and operation of pollution control devices on Federally operated vessels be accelerated in accordance with the immediate objectives and long-term goals herein developed.

Through this and related activities, the Federal Government, through its various segments, can demonstrate proper leadership in the control of water pollution from the operation of vessels.

3. Efforts be expanded to promote uniform State regulation for effective control of water pollution from vessels, with emphasis on adequate enforcement mechanisms.

4. Consideration be given to such additional Federal legislation as is desirable and necessary to control such pollution.

Legislative recommendations are to be made to the Congress by July 1, 1967, under the requirements of Section 17 of the Clean Water Restoration Act.

5. Vessel pollution control programs and related RDT&E activities of the various Federal departments and agencies which operate vessels be coordinated and expanded.

The Interdepartmental Committee on Pollution from the Operation of Vessels, established pursuant to Section 8 of Executive Order 11288, is a proper vehicle through which the FWPCA can take the lead in this.

6. Vessel operators and related interests be consulted for their views and constructive comments on a continuing basis with the objective of developing a closer working relationship and achieving maximum cooperation with Federal water pollution control programs.

The establishment of a marine industries advisory committee would provide a proper vehicle for such consultation.

PURPOSE AND SCOPE

In accordance with Section 8 of Executive Order 11288, the extent of the problem of pollution from vessels has been reviewed and evaluated, and recommendations for corrective and preventive action have been developed.

All navigable waters of the United States have been considered in the study -- coastal waters with their bays, sounds and inlets and the myriad of rivers, lakes and canals comprising the Nation's major inland water resources. This report represents an initial assessment of the degree and magnitude of the problem which may be further refined by future studies. The great diversity in vessel size, type, usage and operating conditions is recognized.

Also in accordance with Executive Order 11288, the Secretary of the Interior requested the Secretary of Defense, the Secretary of the Treasury, the Secretary of Commerce and the Secretary of Health, Education, and Welfare to designate representatives to assist in the study and in the preparation of this report. These designess, together with representatives of the Department of the Interior (Federal Water Pollution Control Administration), constitute the Interdepartmental Committee on Pollution from the Operation of Vessels. A list of the members of this Committee is attached as Exhibit I.

BRIEF BACKGROUND

Navigation is one of man's oldest forms of transportation. From the crudest floating log to today's atomic powered super carrier, man has endeavored to improve the speed, reliability, cost, etc., of such transportation. In most instances, sewage is discharged untreated into the waters on which the vessel floats just as it has been since the beginning of navigation. The disposal of sewage from vessels may have been mechanized for the convenience and sanitation of vessel occupants, but its effects on the receiving waters are generally unchanged throughout history.

A start - but only a start - has been made to deal with this problem. Laws have been passed by the Federal government and more than half of the states dealing with some aspects of the problem. Exhibit 6 of this report reviews and summarizes applicable laws and regulations.

Over the past several years, many influential organizations have taken an interest in the control of pollution from vessels. The New England Interstate Water Pollution Control Commission and the State of New Hampshire began discussions in 1957 with the American Boat and Yacht Council relative to the development of a method of sewage treatment for small watercraft. Subsequently, the American Boat and Yacht Council developed standards and recommended practices for sewage treatment devices for marine toilet wastes. These standards refer to maceration of sewage solids and chlorination to promote thorough disinfection.

The recreational watercraft industry has developed a "Model Act on Sewage Disposal from Boats," which has been distributed widely by the Outboard Boating Club of America. This "Model Act," which is recommended for adoption by the states- is a manifestation of this industry's growing recognition of the value of clean waters and the need for uniform pollution control statutes permitting boats and vessels to move freely from State to State. The National Association of State Boating Law Administrators has set up a special committee to consider the pollution problems of recreational watercraft and also has proposed a model act for sewage disposal from small craft.

To date approximately 12 states have adopted laws similar to these proposed model acts which allow the discharge of disinfected sewage, while about an equal number of states have adopted even stricter control measures by prohibiting the direct discharge of sewage from recreational watercraft. In May of 1960, the Interagency Committee on Sewage and Waste Disposal from Vessels was founded under the leadership of the U. S. Public Health Service to investigate the problems of vessel sewage treatment. Early in 1963, FWPCA began disseminating information on the control of vessel wastes and promoting state consideration of this pollution problem. Additionally, FWPCA has taken action on this problem through surveys and studies such as the San Diego Bay Project which is now in progress. The National Sanitation Foundation, through a grant from the U. S. Public Health Service, is working toward the development of criteria for evaluating and approving waste treatment devices for installation on board small watercraft.

The Association of State and Territorial Health Officers recommended on November 12, 1964 that a program be developed for harbors, bays, inlets and recreational waters (including control of the discharge of wastes from vessels) for which can be implemented by state and local health sanitation agencies. The Federal Water Pollution Control Advisory Board has also considered water pollution from both ocean going ships and recreational watercraft by adopting resolutions at its April 16-17, 1964 meeting. Many other groups and individuals have expressed their concern and made important contributions toward a proper resolution of the problem of water pollution from vessels.

Congress also has officially recognized the importance of water pollution from vessels in two portions of the Clean Water Restoration Act of 1966. Section 17 of this act requires the Secretary of the Interior to study and report to the Congress on litter and sewage pollution from watercraft along with recommendations for any needed legislation. This act also transfers the administration of the Oil Pollution Act of 1924 to the Secretary of the Interior and extends its coverage thereby providing the opportunity for further advances in the control of oil as a water pollutant.

The President of the United States and Executive Order 11288 stressed the importance of water pollution from the operation of vessels by providing the directive for the preparation of this report.

SOURCES OF POLLUTION

Commercial vessels in the United States include 45,779 documented vessels (vessels which have Federal registry or license), 11,100 of which are without propelling power of their own. Included in the documented Merchant Marine are 16,000 fishing boats, 11,500 freighters, 5,800 passenger-carrying vessels, 5,500 towboats, and 2,000 tankers. Almost 4,000 tugs and towboats are used to propel more than 17,000 barges (not documented) on the inland and intercoastal waterways. About 350 documented vessels are used for domestic shipping on the Great Lakes. The commercial fishing fleet adds more than 65,000 non-documented vessels to this number. In addition, a large number of foreign flag vessels use American waters; an estimated 80 percent of the 51,000 entrances through customs into American waters in 1964 were of foreign registry.

Recreational watercraft in the United States numbered 3,500,000 in 1950. By 1960, the number had nearly doubled, reaching almost 7,000,000. Today, there are 8,000,000, and at least 250,000 more are being built each year. Of the total, an estimated 1,290,000 craft are equipped with toilet facilities.

To service this recreational watercraft fleet there are some 5,500 marinas and uncounted private slips and docking facilities located on almost all waters of the United States.

Military and other Federal vessels comprise the third major segment of vessels plying United States waters. Currently, the Navy is operating some 668 vessels based in United States ports; the U. S. Coast Guard, 403 vessels; the Corps of Engineers, 321 vessels; and the Maritime Administration, 119 vessels (as of 9/1/66). Other departments and agencies of the United States Government also operate some vessels, but their number is comparatively small.

WASTE CHARACTERISTICS - THEIR EFFECT ON WATER USES

Vessel wastes fall in several categories that have varying impact on water uses. For consideration these may be grouped into the six general categories of 1) Sanitary wastes, 2) Litter, 3) Bilge water, 4) Ballast water, 5) Wash water and 6) Accidental cargo discharges.

Sanitary wastes include toilet wastes and other sewage which may be generated aboard and discharged from vessels. Wastes from man and animal may carry high concentrations of pathogenic organisms that cause diseases such as dysentery, shigellosis, typhoid or paratyphoid fevers, gastroenteritis, infectious hepatitis and other diseases. Unless killed by proper treatment these organisms can make waters into which they are discharged dangerous to humans as a source of drinking water, for swimming and other water sports, and as shellfishing areas. Such wastes are largely organic in nature and, if present in large quantities in the receiving waters, can use all of the dissolved oxygen on which fish and other aquatic organisms depend for life.

The amount of sewage discharged from vessels into waters of the United States can be approximated by the amount of time people spend aboard vessels that have installed sanitary facilities. It is estimated that 1,290,000 recreational watercraft are equipped with toilet facilities and the occupancy rate of these craft is 165,000 man-years per year. Similarly, the occupancy rate for all commercial vessels is estimated to be 199,000 man-years per year, and the occupancy rate for federally operated vessels is estimated to be 138,000 man-years per year. Hence, the total occupancy rate for all vessels that are equipped with sanitary facilities in waters of the United States in on the order of 500,000 man-years per year. Total sewage discharges from vessels, although widely dispersed, are roughly equivalent to sewage from a city the size of Cincinnati, Denver, or Memphis. This discharge of sewage from vessels is not localized as from a city, but is widely scattered with local concentrations in harbors, bays, and coves. It is not constant but may fluctuate with high concentrations on some days and no discharge in the same areas at other times.

Certain characteristics of vessels make it necessary to assure a high degree of treatment of vessel wastes before allowing such wastes to be discharged into the waters of the United States. Vessels are highly mobile; for example, a commercial vessel which today is discharging sewage or ballast wastes or other polluting materials harmlessly on the high seas may be contaminating the bathing beaches of Florida tomorrow. Or a group of recreational watercraft moored and unused today may congregate for a weekend boat-in and contaminate a previously uncontaminated shellfish bay or a bathing beach or other critical water area. Many of the areas in which vessels congregate are already experiencing severe water pollution problems and on-shore communities in these areas are being required to provide secondary treatment and, in some cases, even more advanced sewage treatment. In contrast, vessels in many areas are not required to provide any treatment of their sewage. It appears reasonable in most instances, therefore, to expect and require vessels to provide, whenever feasible, a minimum of secondary treatment and disinfection of their sewage before discharging it into waters of the United States. Particular problem areas, such as inland lakes experiencing eutrophication, water supply intake areas and contact water sport areas may require higher degrees of treatment even to the extent of prohibiting sewage discharges for proper protection of the waters of the United States.

Litter is considered to be any solid material such as garbage, trash, rubbish, etc. which may be thrown or otherwise discharged from a vessel. Each one of the more than 8 million vessels which use the waters of the United States is a potential source of litter. It has been estimated that a commercial vessel with a crew of 40 generates 4 bushels of litter each day. While the amount of refuse thrown from vessels is not precisely known, there is no question that it is a large part of the total problem and one of substantial esthetic significance.

Bilge water is the drainage collected in the lower portion of a vessel which is derived from the internal drainage of many miscellaneous sources within a vessel. It may contain sanitary wastes from wash basins and showers, lubricating oils leakage from engine rooms and other machinery spaces, and a variety of materials from cargo, food handling, laundry and other areas.

This water may be no more noxious and polluted than the seepage water which infiltrates all vessels, or it may be highly polluted, malodorous and hazardous to humans. As an example of this hazard, shigellosis is reported to have been transmitted through bilge water discharges.

Ballast water is water pumped into fuel tanks or ballast water tanks to maintain proper stability in a vessel which is not sufficiently laden with cargo and/or fuel oil to maintain proper stability. Many ballast waters, particularly those from fuel oil tanks, contain objectionable amounts of oils which can discolor everything they touch and can also be the source of taste and odor problems in domestic water supplies. Many may contain exotic chemicals while others may contain pathogenic organisms with harmful potentials.

The major portion of all oily waste water from a vessel will be water used for ballast which may be fresh or salt or a mixture of the two. Salt water is usually free from suspended solids whereas fresh surface water, such as obtained from the Mississippi River, may contain large amounts of silt. In addition, ballast water may contain finely divided rust and precipitated chemicals used in tank cleaning. The oil contained in ballast water will range from gasoline to heavy fuel oils.

Oily waste water, whether from ballast tanks or bilges, may cause fire hazards and discoloration of vessels, piers, docks, and other structures at the water line. Oily waste water also contaminates beaches and destroys valuable birds, fish and other aquatic life. Ocean-going and coastal vessels often contaminate harbors and coast lines by pumping ballast and bilges too close inshore.

In 1964, 5,243 American flag and 10,682 foreign flag vessels entered American ports in ballast. These vessels represent a combined cargo capacity of 53 million net tons. If only these 10,682 vessels and no others discharged their ballast water, which may have been drawn from the

polluted water of any harbor in the world, into American harbors, they would have discharged 458 million gallons of water and 159,000 tons of oil. The total amount of ballast and bilge water discharged in or near American harbors cannot be accurately estimated but it is believed to be very substantial.

Wash waters are the waters from cleaning operations in any part of a vessel. The problems created by the discharge of wash waters may be both esthetic and chemical. Compartment washings may contain substantial amounts of the materials contained in the vessel's cargo such as molasses, sugar, chemicals, etc., plus whatever agents and detergents are used for cleaning. Often only steam and water and used to clean compartments so that the major source of detergents would be from laundry facilities and the cleaning of the vessel's super structure, hull, bulk heads and decks. Wash water from engine room spaces will normally contain some oil accumulations from leakage in the oil system.

Accidental cargo discharges include any materials in vessel cargos which are accidentally spilled and also the deposition of any such cargo materials into waters of the United States by collisions, groundings, sinkings and other navigational accidents. A wide variety of problems may arise when for one reason or another the cargo is spilled or dumped into the water. Such spillage may be due to a parting or mishandling of a cargo oil hose, a leaking cargo compartment, or other similar occurrences. In some instances, there are accidental discharges for a significant period of time before the condition is corrected.

As the result of such accidental cargo discharges, water for municipal systems may be made unfit for human consumption. Fish and other aquatic life may be killed. Water in streams or on beaches may be contaminated with oily, sticky, dark-colored or malodorous materials which make these waters unfit for recreational purposes. Obnoxious odors or vapors may contaminate the atmosphere in areas nearby. In some cases, accidental cargo discharges have endangered human life.

REMEDIAL MEASURES

Sanitary wastes from vessels can be controlled now in many cases through the application of available technology. At the same time additional technology isneeded to achieve complete control of pollution from these wastes.

Complete control of sanitary wastes from a majority of vessels of all sizes can be achieved within the limits of present technology by installing and utilizing on-board holding tanks, shoreside connections and/or incinerators. For on-board holding tanks and shoreside connections to be of value, adequate shoreside connections and sewage treatment facilities must be available at ports, docks, marinas and other convenient locations. Provision of these shoreside support facilities will require the concerted, cooperative efforts of many agencies, political subdivisions

and persons. Such facilities cannot be made universally available overnight. Yet such facilities or their equivalents in effectiveness must be provided to prevent water pollution from the operation of vessels.

Where the nature or mission of a vessel does not allow the use of the above devices, on-board treatment should be considered. Biological processes, which provide secondary treatment of sewage are now in use in certain vessel situations, and could be more widely used for pollution control. On-board treatment systems which will perform the equivalent of secondary treatment are under development by both the U. S. Coast Guard and the U. S. Navy.

Particularly in the cases of older vessels and special purpose vessels it may be impractical either on the basis of engineering difficulty or economics to utilize any of the above systems for control of sewage pollution. In such cases disinfection equipment should be installed to reduce the hazards to human health and minimize esthetic degradation of our waters. Such equipment should be considered only as an interim solution to the problem, to be replaced as more adequate solutions become available.

Two types of development are needed to achieve adequate pollution control of sanitary wastes from vessels. One, which can be realized within the limits of current technology, is the installation of sewage receiving facilities at docks, ports and marinas to permit the discharge of the contents of on-board sewage holding tanks and to collect sewage discharges from vessels during their stay in ports and marinas. Another, in the realm of research and development, is on-board sewage treatment devices which will provide secondary or higher treatment while utilizing minimal space and weight capacities of the vessels. Functional improvements in existing devices are also desirable.

Bilge, ballast and cleaning waste-waters can also be treated to reduce or remove their pollutional properties. The discharge of these materials to shoreside treatment or into lighters for transport to shore-based facilities could be effected within present day technological limits. Techniques for minimizing the discharge of oil from tanker operations have been developed and could be more widely applied.

An effective on-board oil separator capable of removing small amounts of oil from large volumes of water is needed, as are oil detecting devices capable of indicating and recording the oil content of these waste waters.

Litter control is primarily a matter of education and enforcement. Litter materials can be incinerated on-board or stored for proper shoreside disposal.

Improved material handling techniques for transferring litter from vessels to proper shoreside disposal sites may find application in commercial and other large vessels. Handling systems which reduce the required labor and minimize human contact with disagreeable materials would tend to promote proper disposal of litter and reduce the frequency of immediate over-the-side disposal.

ON-GOING PROGRAMS

Several departments and agencies of the Federal Government have on-going programs to control and reduce pollution of the waters of the United States by discharges from vessels. The FWPCA, along with other Federal agencies, participated in the Interagency Committee on Sewage and Waste Disposal from Vessels which studies pollution from vessels and made recommendations for the protection of public health. The FWPCA has a project in conjunction with the U. S. Coast Guard to determine the cost and effectiveness of certain on-board treatment devices, a project to evaluate the pollutional effects of vessels in San Diego Harbor and disseminates information on vessel pollution control. The FWPCA is assisting one of the States in developing controls for pollution from houseboats and has investigated pollution from vessels in conjunction with a number of its programs and projects.

The U. S. Corps of Engineers has planned the installation of sewage treatment devices on 321 of its vessels. It is anticipated that 255 of these installations will be completed by the end of this fiscal year, and the remaining 66 devices are projected for installation by early 1970. The U. S. Coast Guard is working on on-board sewage treatment devices, is projecting the installation of sewage treatment equipment on new Coast Guard vessels, and is planning to retrofit certain existing vessels with on-board treatment devices. The U. S. Navy is also participating in programs for on-board sewage treatment and is projecting the installation of such equipment on new vessels. The U. S. Maritime Administration is participating in and supporting technical projects on oil elimination and detection equipment for on-board control of oil pollution.

RESEARCH AND DEVELOPMENT

Several Federal agencies are conducting and supporting research and development on vessel pollution both as part of the other on-going programs and as special projects. The U. S. Coast Guard is developing a centrifuge-disinfection system to remove solids from sewage and disinfect the clarified water before discharge. The Coast Guard is also testing and evaluating on-board aerobic treatment devices and developing an improved aerobic treatment process. The U. S. Coast Guard and FWPCA are working jointly to test and evaluate on-board disinfection equipment (macerator-chlorinator) for sewage. U. S. Navy projects include the development of an on-board treatment system in which solids are removed from sewage and incinerated and extensive testing and evaluation of on-board disinfection devices. The Maritime Administration is sponsoring research and development of on-board devices to remove even small amounts of oil from bilge, ballast and other waters discharged from vessels. Certain aerospace research may also develop sewage disposal systems of interest to vessel operators.

Research and development needs involve the development of a more efficient, light weight treatment system which will provide secondary treatment of wastes. Also there is urgent need for design standardization of shoreside facilities for receiving wastes from vessels.

Because of space limitations and weight factors, facilities and processes for treatment of vessel wastes present problems quite different from those associated with treatment of wastes from land installations. Additional and resourceful research and development on this difficult aspect of the total pollution control effort is, therefore, of compelling importance.

FEDERAL EXPENDITURES

Present level of Federal efforts to develop and effect appropriate control of water pollution from the operation of vessels are exceedingly modes, totaling slightly more than $2,000,000 in FY 1967. These expenditures which are detailed in Table I will have to be substantially increased to accomplish the needed control of vessel pollution.

TABLE I

Federal Expenditures for Control of Water Pollution from Vessels

FY 1967

Agency	RDT&E	Control Facilities	Total
HEW-USPHS	5,000	---	5,000
Interior-FWPCA	253,000	---	253,000
Treasury-USCG	15,000	75,000	90,000
Commerce-Maritime Administration	64,000	---	64,000
Defense-U. S. Corps of Engineers	---	1,017,000	1,017,000
U. S. Navy	750,000	---	750,000
TOTAL	1,087,000	1,017,000	2,179,000

LEGISLATION

There are now both Federal and State statutes and regulations intended to control pollution from vessels. Among the Federal statutes are the Refuse Act of 1899 and the New York Harbor Act of 1888 which prohibit the dumping of litter into navigable waters of the United States, usually as a protection for navigation; the Oil Pollution Act of 1924 which prohibits the discharge of oil into the navigable and coastal waters of the United States; and the Oil Pollution Act of 1961 which confirms United States participation in an international treaty to prevent pollution of the seas by oil. Federal regulations prohibit the discharge of sewage and waste waters near potable water intakes in the Great Lakes and near the Saint Lawrence Seaway and restrict the disposal of meats of foreign (but not domestic) origin and garbage of foreign or interstate sources in the United States.

Recent legislation may also have some effect on pollution from vessels. The Water Quality Act of 1965 requires the establishment of water quality standards on interstate and coastal waters. When established, these standards will apply to all sources of pollution and may restrict vessel discharges in these waters. The Clean Water Restoration Act of 1966 amended the Oil Pollution Act of 1924 to place administrative control of the Act with the Secretary of the Interior and to extend its coverage from coastal navigable to all navigable waters of the U. S. Additionally, this Act requires the Secretary of the Interior to make a report to Congress, together with his legislative recommendations on sewage and litter pollution from vessels.

Of the 50 States, 28 have laws or regulations specifically controlling discharges of vessels while 22 have no such law or regulation. Of these 28 States, 12 allow no sewage discharge from vessels; 18 approve holding tanks; 11 approve incinerators; 11 approve macerator-chlorinators and 5 require approved treatment devices not otherwise specified. Two States indicate a preference for disinfection devices even though they do not have a specific law or regulation for vessels.

The laws and regulations controlling discharges from vessels are only partly effective and leave several important areas imperfectly controlled. Sewage may be discharged untreated into many waters of the United States. Other waste waters, which can cause substantial pollution, can be discharged almost without restirction. Litter is not effectively controlled by Federal statutes and is the subject of control in only a few States.

The lack of uniformity of State laws hinders the interstate travels of vessels, as pollution control systems installed in conformance with the laws of one State may not be legal in a neighboring State. For this reason, efforts to promote uniform State laws should be continued and the need for Federal legislation placing common restrictions on the discharges of

all vessels which use navigable waters of the United States should be evaluated as it may appear to be necessary in order to have uniform vessel requirements. Such legislative evaluation should consider both solid and liquid waste discharges from vessels and should consider the requirement of appropriate shore-based support for vessel pollution control systems.

REMEDIAL MEASURE GOALS

In the foregoing discussion vessels of all types, sizes, and ownerships have been considered. Executive Order 11288 directs the control of water pollution from Federal activities. In keeping with the intent of this Executive Order, the following remedial measure goals are directed specifically toward Federally operated vessels. It is believed that these goals can be achieved through executive direction and that they offer an excellent opportunity for the several Federal agencies to exercise leadership in achieving and promoting water pollution control. These goals should also be considered as representing proper objectives for the general problem of water pollution from all vessels.

Remedial measures must be applied which will effect control of water pollution from vessel operation. For these remedial measures to be applied in an orderly and effective manner, the water pollution goals to be achieved by them should be clearly set forth. These long-term goals represent conditions which are not expected to be attained in the immediate future in all cases. As immediate goals to be accomplished as soon as possible:

1. All Federally operated vessels should be equipped with sewage holding devices or on-board treatment facilities which will provide the highest practicable degree of treatment considering the nature and mission of the vessel. As a minimum requirement, these facilities must provide treatment such that the discharge shall be substantially free from floating or settleable solids and contain not more than 1,000 mpn coliform bacteria per 100 ml at, or immediately preceding, the time of discharge.

2. Vessels such as houseboats and floating dormitories, which are generally stationary, should be connected to shoreside facilities that provide secondary or such other degree of treatment as is required for the waters to which the treated wastes are discharged, or should provide such treatment on-board.

3. The discharge of any sewage and other wastes should be prohibited within the immediate area of potable water supply intakes or contact water sport areas and shellfish growing beds.

4. Litter, garbage, trash, dunnage and related materials should be incinerated or stored on-board for suitable disposal on shore.

5. Coordinated programs of research, development, test and evaluation and installation of sewage treatment hardware which will provide secondary treatment, or its equivalent, in vessel sewage discharge regardless of special limitations placed on such equipment by the nature and mission of the vessel concerned should be continued and initiated.

As long-term goals:

1. All Federally operated vessels should provide sewage holding devices or secondary treatment and disinfection or its equivalent to all sewage before discharge into waters of the United States.

2. All polluted or contaminated bilge, ballast and other waters should be treated to remove their pollutional properties before discharge. The discharge of contaminated, or otherwise objectionable, wash waters from engine rooms, cargo holds or other areas and chemicals or other polluting substances should be prohibited into the waters of the United States except in an emergency.

APPENDIX

Members of Interdepartmental Committee on Water Pollution from the Operation of Vessels

Department of Commerce

William G. Allen, Chief
Division of Operations
Office of Ship Operations
Maritime Administration

Department of Defense

Colonel Alvin F. Meyer, Jr.
Chairman of the Department of Defense Environmental Pollution Control Committee
Principal Defense Member

Captain William R. Riblett
Director of the Propulsion, Power and Auxiliary Systems Division of the Naval Ships Systems Command

Mark S. Gurnee, Chief
Operations Division, Civil Works
Office of the Army Chief of Engineers

Department of Health, Education, and Welfare

Malcolm C. Hope, Acting Chief
Division of Environmental Engineering and Food Protection
Public Health Service

Eugene T. Jensen, Chief
Shellfish Sanitation Branch
Division of Environmental Engineering and Food Protection
Public Health Service

Robert E. Novick, Regional Program Director
Division of Environmental Engineering and Food Protection
Public Health Service - Region V
Chicago, Illinois

Department of the Interior

Ernst P. Hall, Chairman of the Interdepartmental Committee
Staff Assistant, Technical Programs
Federal Water Pollution Control Administration

Hendon M. Crane, Chief
Federal Activities Coordination, Facilities Programs
Federal Water Pollution Control Administration

Department of the Treasury

Captain James B. McCarty, Jr., Chief
Merchant Marine Technical Division
United States Coast Guard

Captain J. H. LeVan
United States Public Health Service
Chief Sanitary Engineer Officer
Medical Division
United States Coast Guard

Cdr. Malcolm E. Clark, Chief
Ship Maintenance Branch
United States Coast Guard

POLLUTION POTENTIALS OF VESSELS* - HUMAN WASTES

A facet of vessel pollution which may be estimated with some accuracy is the pollution from human wastes. To bring human body waste discharges from the many types of vessels and vessel uses to a common base, an average occupancy rate (similar to population equivalent) has been estimated for several vessel use categories. The rationale for this method of compilation is widely used. Basically, it multiplies the number of persons involved by the number of hours per year each occupies a vessel equipped with sanitary facilities and divides this number of man hours by the number of hours in a year to develop an average annual occupancy rate.

Table II summarizes the calculated average occupancy rates for several categories of vessel use. In using this table, it should be noted that the pollution figures are estimated potentials only and that the potential may not be fully realized in some cases. It should also be recognized that small and miscellaneous use vessels have not been included. While these vessels do contribute to pollution, there is no known rational basis for estimating their pollution potential at this time.

The total human waste pollution potential from vessels is estimated to be equivalent to 502,400 persons or less than 0.3 percent of the population of the United States. If the occupancy rate for all vessels is equivalent to only 0.3 percent of the Nation's population, this pollution cannot be rationally classified one of the most important pollution problems facing the Nation. It is, nonetheless, a growning problem which should receive due and rational consideration. Local estimates of pollution from vessels range from 0.2 percent of the drainage basin population to as high as 1 to 5 percent in certain locations. Comparing this overall national estimate of pollution potential with local estimates indicates that the national estimate is within the range of local estimates and gives a considerable degree of confidence that it is a realistic and rational estimate.

* THE TERM "VESSEL" AS USED THROUGHOUT THIS REPORT HAS THE GENERAL, AND NOT THE LEGALISTIC MEANING. AS USED HEREIN, A VESSEL IS A CRAFT FOR TRAVELING ON WATER, A SHIP OR BOAT, ESPECIALLY ONE LARGER THAN A ROWBOAT.

Table II

POLLUTION POTENTIAL OF VESSELS
HUMAN WASTES

Category	Occupancy Rate Man years/year		Per cent of total	
Commercial				
Foreign Commercial-Cargo & Tanker	105,900		21.1	
Foreign Commercial-Passenger & combinations	6,100		1.2	
Inland-Intercoastal	53,000		10.5	
Great Lakes-Domestic only	9,200		1.8	
Coastwise-Domestic	24,800		5.0	
Total Commercial		199,000		39.6
Recreational Watercraft		165,000		32.9
Military-Government				
U.S. Navy	128,400		25.5	
U.S. COE	2,900		0.6	
U.S. Coast Guard	6,600		1.3	
U.S. Mar. Ad. (MSTS)	500		0.1	
Total U.S. Government		138,400		27.5
GRAND TOTAL		502,400		100.0

Exhibit 2
Page 2

A. POLLUTION POTENTIAL OF RECREATIONAL WATERCRAFT

Recreational watercraft comprise the largest number of vessels of any category -- many times larger in fact than all government-owned and commercial vessels combined. Estimating the number, size and water pollution contribution of these units is difficult as firm surveys and statistics on this aspect of recreational boating are not readily available.

Under the Federal Boating Act of 1958, the States have the right to register boats in their waters. If this option is exercised, a State is obligated to register boats of more than 10 horsepower that are used in Federal waters of that State. State registration laws may go beyond this requirement, but they must be approved by the Coast Guard in order to comply with the Federal law. By July 1966, 46 States were numbering boats under approved systems, but 24 of these reportedly had not registered all boats that come under their laws. The Coast Guard, at this time, is the numbering agent in the remaining four States and the District of Columbia, Guam and Puerto Rico, but it numbers only those boats of more than 10 horsepower which are on Federal waters.

Of the 46 States with approved systems, three have laws that cover registration of all watercraft. Twenty number all motorboats (irrespective of horsepower) and 13 number all motorboats over 10 horsepower (New Jersey is counted twice in this tally because this State numbers all motorboats on non-tidal waters but only boats over 10 horsepower on tidal waters). Four States number motorboats of 10 or more horsepower, and one numbers all motorboats over 7 1/2 horsepower. Three States require the registration of only motorboats of more than 5 horsepower; another 5 or more horsepower. One State registers motorboats of 3 1/2 or more horsepower.

Table III shows the number of boats registered in each State and the District of Columbia, according to the U. S. Coast Guard. These statistics indicate that there are, in all, 4,138,140 registered boats.

The boating industry, through its several trade organizations, publishes various statistics bearing on the overall pollution problem. Table IV summarizes pertinent statistics from these sources.

No statistical information is available on the number of recreational watercraft equipped with toilet facilities. The following derivation must be clearly labeled as an estimate of the pollution potential of such craft and used only as a guide to their gross pollution potential. It is estimated that more than 90 percent of the 570,000 inboard powered boats

TABLE III

Numbered Recreational Watercraft

State	Boat Numbers Outstanding	Scope of Numbering System
Alabama	87,857	All motorboats
*Alaska	16,883	More than 10 hp.
Arizona	20,806	All watercraft
Arkansas	21,057	More than 10 hp.
California	341,033	All motorboats
Colorado	14,554	All motorboats
Connecticut	54,633	More than 5 hp.
Delaware	7,941	All motorboats
*District of Columbia	3,524	More than 10 hp.
Florida	145,691	More than 10 hp.
Georgia	69,384	More than 10 hp.
*Hawaii	7,045	More than 10 hp.
Idaho	30,488	All motorboats
Illinois	156,605	All motorboats
Indiana	135,493	All motorboats
Iowa	66,456	All motorboats
Kansas	25,391	More than 10 hp.
Kentucky	45,444	All motorboats
Louisiana	69,509	More than 10 hp.
Maine	40,074	More than 10 hp.
Maryland	76,723	More than $7\frac{1}{2}$ hp.
Massachusetts	88,433	5 hp. or more
Michigan	398,608	All motorboats
Minnesota	211,630	All watercraft
Mississippi	36,419	More than 10 hp.
Missouri	59,725	More than 10 hp.
Montana	12,758	More than 10 hp.
Nebraska	21,278	All motorboats
Nevada	19,268	All motorboats
*New Hampshire	5,733	More than 10 hp.
New Jersey	120,090	More than 10 hp.
New Mexico	10,119	10 hp. or more
New York	393,441	All motorboats
North Carolina	66,470	More than 10 hp.
North Dakota	9,122	10 hp. or more

*States not having a Coast Guard approved boat numbering system as of 31 December 1965.

Cont'd next page.

TABLE III(Cont'd)

State	Boat Numbers Outstanding	Scope of Numbering System
Ohio	154,741	All watercraft
Oklahoma	83,484	All motorboats
Oregon	63,049	More than 3½ hp.
Pennsylvania	106,687	All motorboats
Rhode Island	20,143	All motorboats
South Carolina	52,022	10 hp. or more
South Dakota	11,608	More than 6 hp.
Tennessee	70,933	More than 10 hp.
Texas	207,469	More than 10 hp.
Utah	17,140	All motorboats
Vermont	18,453	All motorboats
Virginia	56,773	10 hp. or more
*Washington	96,719	More than 10 hp.
West Virginia	10,044	More than 5 hp.
Wisconsin	268,829	All motorboats
Wyoming	7,170	More than 5 hp.
*Guam	181	More than 10 hp.
*Puerto Rico	2,486	More than 10 hp.
Virgin Islands	524	All motorboats
U. S. Total Known to Coast Guard	4,138,140	

*States not having a Coast Guard approved boat numbering system as of 31 December 1965.

Table IV

Recreational Watercraft Statistics

39,325,000 persons participated in recreational boating, making use of the waterways more than twice during 1965

7,865,000 total number of recreational boats in existence on all waters of the United States. This total is made up as follows:

- 570,000 inboard motorboats in use on all waters of the United States, including auxiliary powered sailboats and boats documented by the U. S. Bureau of Customs. This figure includes 38,500 inboard boats solid in 1965.
- 4,530,000 outboard boats in use.
- 535,000 sailboats without inboard power, on all waters.
- 2,230,000 rowboats, canoes, dinghies, prams and other miscellaneous craft in use. Many of these are used with outboard power.

4,200 houseboats in existence. 1,250 houseboats sold in 1965.

OUTBOARD BOATS

Year	Total Number of Boats Sold	% more than 16.5' long	Number sold* more than 16.5' long	Inboard-outdrive boats sold
1965	250,000	20.6	52,000	17,000
1964	250,000	19.8	50,000	12,000
1963	245,000	22.5	55,000	8,000
1962	239,000	17.0	41,000	
1961	237,000	18.9	45,000	
1960	294,000	12.2	36,000	
1959	329,000	8.4	28,000	
Total	1,844,000		307,000	37,000

2,686,000* outboard boats in use but sold before 1959

*This information calculated using these published statistics.
NOTE: These statistics selected from statistical information prepared by the editors of "The Boating Industry," and information prepared jointly by the National Association of Engine and Boat Manufacturers and the Marketing Department of the Boating Industry Association. Both publications indicate that all industry figures are estimates.

and the 37,000 inboard-outdrive boats are equipped with toilet facilities. It is further estimated that 50 percent of the sailboats without auxiliary power and 80 percent of the outboard boats of more than 16.5 feet length are equipped with some form of toilet facility. To develop the total number of outboard boats of more than 16.5 feet length, it is necessary to estimate the percentage of such boats sold prior to 1959. For this estimate, the figure of 10 percent has been selected as realistic. Table V shows the estimated number of watercraft in each category having toilet facilities.

Table V

Watercraft Having Sanitary Facilities
(Estimated from Industry Data)

570,000	inboard powered boats	(570,000 x 0.90)
33,000	inboard outdrive boats	(37,000 x 0.90)
267,000	sailboats	(535,000 x 0.5)
244,000	outboard boats sold after 1959	(305,000 x 0.80)
215,000	outboard boats sold before 1959	(2,686,000 x 0.10 x 0.80)
1,272,000	Total recreational watercraft with sanitary facilities	

To check the above estimate, another calculation has been made using data collected by the United States Coast Guard and the Bureau of Customs. These data indicate that there are 4,138,000 numbered recreational watercraft in the United States and that 31.19% or 1,291,000 of these are 16 feet or greater in length. If 80 percent of these craft are equipped with toilet facilities, some 1,033,000 numbered recreational watercraft are so equipped. To this number must be added the 12,000 documented yachts listed in the Bureau of Customs statistics and the unpowered sailboats.

Table VI

Watercraft Having Sanitary Facilities
(Estimated from Coast Guard Data)

1,033,000	powered recreational watercraft
12,000	documented yachts
267,000	sailboats
1,312,000	Total

There is a close correlation between the number of recreational watercraft estimated to have toilet facilities from industry data and from Coast Guard data. Hence, an average of these estimates or 1,290,000 recreational watercraft equipped with toilet facilities will be used in further calculations.

One detailed study of the movements of recreational watercraft in and out of a marina observed 6,830 trips by boats greater than 15 feet in length. On these trips, the recreational craft carried a total of 24,459 passengers and remained away from port more than 38,608 total hours. From this study, it would appear that the average recreational watercraft carries 3.59 passengers, is away from port 5.66 or more hours per trip and results in an occupancy rate of 20.3 man hours per trip. The frequency of recreational watercraft use was not determined in this study. However, an average of two and one half uses per week during a 22 week boating season appears reasonable. This usage rate does not include day or overnite stays aboard watercraft in port or the extended boating season of the Southern United States and therefore is considered to be quite conservative. If the 1,290,000 recreational watercraft with toilet facilities receive this degree of usage it would result in an average occupancy rate for all recreational watercraft of 165,000 man years per year, comparable to the occupancy rate of a sizable city.

The use of occupancy rates and comparing them with cities must be done with considerable caution. The population of a city is fixed and relatively constant from day to day and week to week while recreational watercraft use tends to be concentrated on weekends, holidays and at vacation periods. The time and location of recreational watercraft use concentrations coincide generally with water contact sport uses, thereby increasing health hazards and esthetic disturbances caused by pollution from this source. Weather conditions also have a considerable effect on watercraft usage, restricting it during foul weather and encouraging it during fair weather. Hence, it should be considered that while the average pollution potential of recreational watercraft is approximately equal to 165,000 people, the pollution potential on a foul-weather day during the middle of the week in the winter season may be almost zero while the pollution potential on a holdiay weekend during fair summer weather may be many times greater than the figure indicated.

It is also worthy of note that the trend in recreational watercraft is toward an increasing installation of on-board toilet facilities. This trend combines with an ever increasing number of recreational watercraft in use to indicate a steadily growing pollution problem from this source.

B. POLLUTION POTENTIALS OF COMMERCIAL VESSELS

Commercial Vessels in Foreign Trade

The group of vessles considered here are those of 1,000 gross tons and over engaged in foreign commerce. Vessels engaged in intercoastal, coastwise, or non-contiguous domestic trade and military and special purpose private vessels are not included.

Vessels of all nations call at American ports. They carry both passengers and cargo and may remain in any given port of call only a few hours or many days. Between their entrance and clearance through American customs, they may call at one or many ports. During their stay in waters of the United States, almost all of these vessels practice over-the-side disposal of sewage.

To arrive at a rough estimate of this pollution potential, a small segment of vessels has been investigated and the information extrapolated to estimate the total sewage pollution potential.

The subsidized portion of the American Flag Fleet was selected since data on the movements, crew size, etc., for these vessels are routinely collected and analyzed by the Maritime Administration. Data relative to these vessels were made available by the Maritime Administration and have been used in conjunction with other published statistical information to derive the following estimates of pollution potential.

In 1964, there were some 312 subsidized vessels in the American Flag Fleet. Twenty-eight of these were combination vessels (cargo and passenger) which completed 380 vessel voyages and 212,807 passenger voyages. (A passenger voyage is one arriving and one departing passenger). The remaining 284 vessels were cargo-type vessels which completed 1,442 voyages during the same period.

Using Maritime Administration data on the number of crewmen aboard and the length of port stays, it is estimated that crews of the cargo vessels spent 3,093 man years aboard the 284 cargo vessels while in the United States waters. Similarly, it is estimated that the crews of the 28 combination and passenger vessels spent 1,335 man years aboard ship while in American waters.

The great difference in crew size between combination and passenger and cargo vessels makes it desirable to estimate the pollution potential from these types of vessels separately.

During 1964, 855,000 passenger voyages were made into and out of the United States on vessels with 24.9 percent of these made aboard the subsidized American Flag Fleet on 380 voyages. Expanding the data calculated for the 380 voyages, the total passenger load would be equivalent to 1,523 voyages and the crew aboard these combination and passenger vessels would have spent 5,350 man years aboard ship in American waters.

The 284 cargo vessels in the subsidized American Flag Fleet completed 1,442 voyages while the crews spent 3,270 man years aboard ship in American waters. During 1964, 50,998 commercial vessels entered through customs into American waters. Assuming that 1,523 of these entrances were by combination and passenger vessels, the remaining 49,475 were by cargo and tank vessels. The subsidized American Flag Fleet represents about 2.92 percent of these cargo vessel entrances, and the total pollution load from crews aboard ship during stays in American waters is estimated at 105,900 man years per year.

The pollutional contribution of the passengers aboard ship is relatively minor in comparison to that of the crews. Passengers arriving aboard ship are usually ready to disembark when the ship docks and remain aboard a minimum amount of time. Passengers embarking usually board the vessel from six to ten hours prior to sailing time. Hence, if each of the 855,000 embarking passengers spent eight hours aboard ship while in American waters, this would be equivalent to 781 man years.

Pollution Potential of Great Lakes Domestic Shipping

Domestic shipping on the Great Lakes (1962) is carried on in a total fleet of 578 Canadian and United States Flag vessels of 1,000 or more gross tons. (Foreign shipping on the Great Lakes is included in vessels in foreign trade.) The U. S. segment of this fleet is 350 vessels. The shipping season is limited because of weather to approximately 9 months of the year. Assuming an average crew of 35, the maximum potential pollution from these American Flag vessels would be equivalent to 9,200 man years per year.

Some of the vessels in the Great Lakes fleet are known to be equipped with secondary type sewage treatment devices. No statistical information is available which details the number of such units but it has been estimated that as many as 15% of the U. S. Flag carriers on the Great Lakes are so equipped.

Pollution Potential of Commercial Vessels on the Inland and Intercoastal Waterways

The inland and intercoastal waterways are used extensively for the transport of commerce. These waterways, comprising some 25,260 miles of navigable waters, were used to transport 457.5 million net tons of goods over 144.2 trillion ton miles during 1964. According to statistics released by the American Waterways Operators, Inc., 3,915 self-propelled towboats and tugs were used to move 17,000 non self-propelled barges in this transport.

The pattern of operation of these towboats and barges is such that most of them operate continuously and only a few operate on a day work basis. The industry association estimates that 80,000 people are employed in operating these 3,915 vessels and that an average of 53,000 individuals are aboard the vessels at all times. Hence, the pollution potential of commercial vessels on the inland and coastal waterways is 53,000 man years per year.

Pollution Potential of Commercial Vessels - Coastwise Domestic Trade

In addition to the domestic trade carried on the Great Lakes and on the intercoastal and inland waterways, there is coastwise commercial traffic among domestic ports. This is reported as 214,000,000 tons in 1963. The number of vessels, size of crews, stops in port or other more definitive data are not available on this trade.

For the purpose of this estimate, it is assumed that the pollution potential of this shipping is proportionate to that of the inland and intercoastal waterways transport. On this basis, the pollution potential of domestic coastwise commercial vessels would be 24,800 man years per year.

Pollution Potential of Commercial Vessels - Commercial Fishing

The group of vessels being considered here are those engaged in commercial fishing either on a full-time or part-time basis. In 1964, there were 11,808 documented vessels and 64,323 undocumented vessels in the American commercial fishing fleet. These vessels may be based (home port) in virtually any coastal or inland navigable waters of the United States although they are principally concentrated in the coastal areas. In size, these vessels vary from dory size (about 12 feet) to vessels about 200 feet long. Manning requirements of these vessels are equally varied with many thousands of boats operated by a single fisherman either full or part-time while the larger 100 to 200-foot vessels may require about 20 men in the crew. The use of these vessels during a calendar year will vary from as low as 25 days (Alaska salmon fishing) to the year-round operation of New England offshore

trawlers. Days absent from port also may vary from a few hours (trap boats and lobster boats) to approximately 90 days (tuna seiners and tuna bait boats).

The living habits of the fishermen are about as varied as their equipment and crew requirements. In many areas, fishermen live on board the fishing vessel during the fishing season and in some areas they use it as their home while it is docked during the off season. In other areas, vessels of all sizes normally return to their home port in the late afternoon, and the crews go ashore to their homes.

It is estimated that there are 127,560 part or full-time fishermen in the United States. Because of the wide variation in vessel use and living habits, no meaningful estimate of their sewage pollution potential can be made at this time. Similarly, disposal practices for fish-cleaning wastes vary widely and cannot be readily estimated. Even though numerical estimates of the pollution potential from fishing vessels cannot be made, this source of pollution should be recognized and considered as one of the many sources of water pollution from the operation of vessels.

C. POLLUTION POTENTIAL OF FEDERALLY OPERATED VESSELS

Pollution Potential of Vessels Operated by the U.S. Navy

At present, the U.S. Navy is operating some 668 vessels of all types in waters of the United States. These vessels are generally on the Atlantic and Pacific coast areas, with only a few units located on the Gulf Coast and Great Lakes. Some 242,000 men serve aboard these vessels; however, shore leave and duty outside of waters of the United States reduce the occupancy rate of men aboard these vessels in waters of the U.S. to 128,400 man years per year. Essentially, none of these vessels is equipped with sewage treatment devices.

Pollution Potential of Vessels Operated by the U.S. Coast Guard

The United States Coast Guard operates some 403 vessels which have the potential of producing sewage and causing or contributing to the pollution of waters of the United States. Of these vessels, 60 which operate wholly or principally within waters of the United States have only toilet facilities while the remaining 343 have toilet facilities and other sewage producing facilities. Of these 343 vessels, 264 operate principally or wholly within waters of the United States while the remaining 79 are ocean-going vessels. Approximately 14,000 persons daily serve aboard these vessels. The pollution potential from these 14,000 persons is equivalent to 6,600 persons (occupancy rate) as many of the crew spend only a portion of the 24-hour day aboard ship, and the ocean-going vessels spend only a fraction of their time in waters of the United States.

The vessels which have only toilet facilities aboard have a combined occupancy rate of 50, and all are equipped with macerator-chlorinator type sewage treatment units. The 264 vessels which operate principally or wholly in waters of the United States and have toilet and other sanitary waste-producing facilities have a combined occupancy rate of 3,600 man years per year. Forty-six of these vessels having an occupancy rate of 522 are equipped with macerator-chlorinator units which treat toilet wastes only, and two of these vessels having an occupancy rate of 75 are equipped with experimental secondary treatment units. None of the 79 ocean-going vessels is equipped with sewage treatment facilities.

The pollution potential from the operation of vessels in waters of the United States by the United States Coast Guard can be summarized as an average occupancy rate equivalent to 6,000 persons whose wastes receive no treatment, 575 persons whose toilet wastes receive disinfection and 75 persons whose wastes receive secondary treatment. The discharge of these wastes is somewhat less subject to weekend, holiday and vacation period peak loading and is somewhat less subject to weather variations than the waste loadings from recreational watercraft.

Pollution Potential of Vessels Operated by the U.S. Corps of Engineers

The U.S. Corps of Engineers operates a total of 321 vessels that are equipped with sanitary facilities. These vessels may operate in all navigable waters of the United States and carry a total complement of 5,028 persons. The normal work cycle of these persons is such that they spend 2,900 man years per year aboard these vessels in waters of the U.S.

As is detailed elsewhere in this report, the Corps of Engineers has equipped, or is planning to equip, all of its vessels with sewage treatment devices.

Pollution Potential of Military Sea Transport Service Vessels

The United States Maritime Administration operates a group of 119 vessels to serve as transport vessels for military needs. These vessels, frequently referred to as MSTS (Military Sea Transport Service) vessels carry an average crew of 44 persons. On the basis of their operations during July and August 1966, they spend 35.8 days per year in U.S. ports. The occupancy rate from this activity in waters of the United States is equal to approximately 500 man years per year. None of these vessels is equipped with sewage treatment devices.

Pollution Potential of Other Federally Operated Vessels

Many departments and agencies of the Federal Government operate vessels. Of these departments, Commerce, Defense, Health, Education, and Welfare, Interior and Treasury are represented on the Interdepartmental Committee on Pollution from the Operation of Vessels. The major Federal operations of vessels are detailed in this report. Other Federal operations of vessels are believed to be relatively small and to have a relatively small water pollution potential. In addition to the departments represented on the Committee, all of which operate vessels, a telephone survey of the Washington headquarters of the several Federal departments and agencies indicated that the following also operate one or more vessels.

Department of Justice
- Bureau of Prisons
- Immigration and Naturalization Service

Department of Agriculture
- National Forest Service
- Agricultural Research Service
- Soil Conservation Service

Independent Agencies and Commissions
- Panama Canal Company
- Federal Aviation Agency
- Tennessee Valley Authority
- Atomic Energy Commission
- Saint Lawrence Seaway Development Corporation
- National Aeronautics and Space Administration

POLLUTION POTENTIAL - OILY WASTES

Cargo, tanker, passenger and military vessels have long been recognized as a potential and, at times, actual source of oil pollution. Oil pollution can occur from the discharge of either bilge or ballast waters. Bilge waters are of an occasional nature and the oil contained therin is from miscellaneous sources, making an overall estimage of the amount of such discharge or the oil it contains virtually impossible. Information supplied by the Maritime Administration indicates the possible magnitude of oil pollution from ballast water discharges.

Most merchant vessels are designed with dual service tanks, better known in the trade as "double-bottom" tanks. The tanks are located in the lowest part of the vessel and contain the fuel oil for the voyage, salt water ballast when the fuel is used up and ballast for stability purposes, or a combination of both fuel oil and salt water ballast in various ratios. Slack tanks (partially filled) are seldom used because the free surface movement of the liquid disturbs vessel stability. A potential source of pollution of the seas stems from the operation of mixing oil and salt water in the same tank, and the requirement to pump out the tank for re-bunkering the tank with fuel oil for the next voyage.

The C1B-type cargo vessel is the average size of a "small" freighter, and a C4-S-1a (mariner) is the average size of a "large" freighter. The fuel and ballast tank capacities, taken directly from the capacity plans of these two designs, indicate:

Type	FO/Ballast Capacity
C1B	1264 Tons
C4 Mariner	3723 Tons
Total	4987

Average----------2494 Tons

Assuming that 40% of capacity would be the maximum amount of ballast ever carried, the maximum will then be 40% of 2494 tons, or 998 tons of ballast water for the average ship. This is rounded out to 1000 tons. Now, by estimating that only 1% of residual fuel is discharged with the ballast water, it is determined that 10 tons of oil is discharged.

Using the same technique as applied to freighters, but for tankers, and different factors, a T2-SE-A2 16,500 DWT tanker was selected as being average. In this instance tankers do not have double bottom tanks, so the ballast water is put in the cargo tanks. The result is as follows:

T2-SE-A2 Type	16,500 Tons (DWT)
Allowance for FO/FW	1,600 Tons
Available for Cargo	14,900 Tons
Ballast @ 40% of Cargo TAnkage	6,000 Tons
Estimating 1/2 of the 1% residual fuel in ballast water - Amount	30 Tons

While the above figures represent the maximum potential oil pollution from American ships only, operating practice indicates that the actual magnitude of oil pollution from this source is considerably less.

In 1964 there were 50,998 vessel entrances through customs into the U.S. of which 5,234 American flag and 10,682 foreign flag vessels entered "in ballast". These statistics do not include domestic trade or military vessels and do not distinguish between cargo and tanker types of vessels. Using the potential pollution developed for cargo vessels, ballast discharges from the "in ballast" entrances are potentially 15,916,000 tons (458,000,000 gal.) water and 159,160 tons of oil.

These figures approximate the maximum potential discharges of ballast water and oil from these 15,916 vessel entrances. Operating practices such as discharging oily ballast water 50 or 100 miles at sea or discharging it into proper shore based treatment facilities may reduce the actual pollution discharges. Many of the remaining 35,082 vessel entrances may discharge some ballast water during fueling or other operations, thereby contributing to oil pollution. Domestic trade vessels also are potential contributors. Military vessels, it is understood, usually discharge ballast water 150 miles at sea unless such discharge would impair the safety of the vessel.

Each of the wide variety of vessels, including tugs and other harbor craft, ferries with their thousands of daily passengers, ocean-going merchant vessels, ocean liners, fishing trawlers, recreational watercraft and special purpose vessels, has a potential for causing pollution through the discharge of sewage, litter, oil and other materials. The potential for oil pollution from vessels in a harbor depends upon the volume of vessel traffic into and out of that harbor. Table VII shows ocean-going vessel arrivals and departures for major ports of the United States.

As an example, the port of New York is further analyzed. Of the 24,580 total arrivals and departures at the port of New York in 1964, 18,682 were in the dry cargo and passenger trades and 5,098 were tankers. These include 6,625 American flag and 12,057 foreign flag cargo and passenger vessels and 3,153 American flag and 2,745 foreign flag tanker vessels. Ocean-going vessels engaged in both foreign and domestic trade are included in these data. Of the vessels which entered through Customs at New York, 252 were "in ballast." The total number of vessels arriving in New York "in ballast" is not known.

Table VII

Arrivals and Departures of Oceangoing Vessels at Major Ports of the United States
1964

Port	Arrivals & Departures (Combined)	No. of Vessels (Estimated)
New York	24,580	12,290
Philadelphia	13,791	6,895
Hampton Roads	11,353	5,676
Baltimore	10,734	5,367
New Orleans	10,400	5,200
Los Angeles-Long Beach	9,467	4,733
San Francisco	9,081	4,540
Houston	8,372	4,186
Seattle	4,171	2,085
Boston	4,168	2,084
Portland, Oregon	4,081	2,040

All vessels have a potential for discharging oil or oily wastes into the waters on which they float. Fueling, bilge water discharge and similar operations, as well as ballast discharge can release oil to cause pollution. The estimated maximum potential oil discharge via ballast water from the 252 "in ballast" vessel entrances is equivalent to 1,104 gallons of oil per day. Spread evenly over quiet water, this amount of oil would pollute more than 1,000 acres or almost 2 square miles of water. Evenly spread along a 20-foot strip of shoreline, this amount of oil would badly degrade some 10 miles of shore per month. As has been noted, not all of this potential oil pollution is realized; however, it must also be considered that these "in ballast" entrances constitute only 2 percent of the total vessels arriving at the Port of New York, each of which has a potential for causing oil pollution.

AN EVALUATION OF PRESENTLY AVAILABLE SEWAGE TREATMENT AND HANDLING SYSTEMS FOR USE ABOARD VESSELS

The treatment or handling of sewage aboard vessels to control and prevent water pollution has received consideration by various interests for several years. During these years, efforts have been made to develop new sewage treatment devices for vessel use as well as to adapt land-based treatment devices for use aboard vessels.

The problems of treating sewage aboard vessels are unique compared to land-based treatment. A vessel is a compact unit wherein space is highly utilized and weight can be a critical and controlling factor. In most vessels, the installation of large heavy sewage treatment equipment requires a commensurate reduction in the vessel's capacity to perform its function. In commercial vessels, this usually means less cargo capacity; in military and naval types of vessels, it could mean reduced combat potentials; in recreational watercraft, it could mean fewer passengers or other reduced recreational potentials. None of these reduced potentials is desirable, but neither is the defilement of our water desirable.

It is necessary, therefore, to consider that some desirable vessel characteristics may sometimes necessarily be sacrificed or compromised to achieve an even more necessary and desirable freedom from water pollution.

Seven basic types or systems of sewage treatment or handling are currently being used aboard vessels. A comparison of the water pollution prevention potential of these systems is shown in Table VIII.

The six basic systems which provide some degree of pollution prevention should be considered in some detail. Each system is briefly described to illustrate its method of operation.

Holding tanks may be installed aboard ship to collect and hold sewage until it can be discharged properly. Holding tanks, when properly operated, result in the complete elimination of sewage pollution from vessel operation as there is no sewage discharge from the vessel to the waters in which it operates.

The use of holding tanks aboard vessels must be combined with the provision of adequate holding tank discharge and sewage treatment facilities at ports, docks, and marinas. Without this shore-based support, holding tanks may cause high local concentration of pollutants in the water areas where they are discharged. Most ports, docks and marinas today do not have adequate facilities to service holding tanks.

One potentially useful variation of the holding tank is the recirculating flush toilet. This device, which is similar to units used aboard jet aircraft, retains sewage from 80 to 100 toilet usages before it must be emptied while using space and weight equivalent to only about 10 gallons of water.

Incinerator devices have been designed to burn human body wastes on-board vessels and are commercially available. One type uses electrical energy to generate combustion heat; another uses fuel oil or liquified petroleum gas. Both types reduce body wastes to an ash which can be easily transported ashore for disposal.

These devices completely prevent water pollution by the materials incinerated in them. However, they are normally used only for toilet wastes and hence do not reduce the pollutional effect of other sewage, such as galley wastes, bath water, laundry water, etc.

Shoreside connections or facilities for transferring sewage from a vessel to land-based treatment plants while the vessel is in port have not been thoroughly developed. Proprietary designs of equipment are available for emptying sewage holding tanks on recreational watercraft and discharging this sewage into hand carts or sewers. Devices for coupling vessel sanitary systems to shore sewers are not known to be commercially available. The problem of connecting vessel sewage discharges to sewers at slips or piers deserves substantial consideration as does the standardization of fittings and connectors for attachment of sewage lines to vessels.

To provide sewage treatment comparable to shoreside connection in marine environments, which are near to but separated from shore, an extended aeration sewage treatment plant has been constructed in a floating deep draft barge type container. A proprietary brand of this device is commercially available. This manufacturer recommends it for use in marinas and recreational water areas to treat sewage discharge from vessel holding tanks and sewage from a floating bath house made by the same manufacturer.

The basic idea of mounting a package type sewage treatment plant aboard a barge for use in marine environments offers a possible solution to certain otherwise difficult vessel waste treatment situations. While no effluent test data are available for the proprietary device, it is probable that barge mounted package type sewage treatment plants would achieve the same degree of treatment as is realized by similar land-based equipment.

Certain aerobic sewage treatment processes frequently used for land-based sewage treatment have been adopted for vessel use. The most successful of these is the extended aeration activated sludge process. In this process, coarse materials are screened out, organic solids broken into small particles, sewage aerated, sludge settled and returned to the aeration chamber, and the supernatant liquid chlorinated before discharge.

Several manufacturers offer this type of equipment, and test results indicate that some proprietary designs may be more effective than others.

One set of test results on a more effective unit indicate the following effluent characteristics: BOD 46 mg/l - 88% reduction; suspended solids 108 mg/l - 89.5% reduction; coliform density after disinfection 460 mpn/100 ml - 99 + % reduction. Other tests on this type of equipment indicate less efficient operation -- even to the point of non-operation.

Trickling filters have been considered for use aboard vessels and at least one test installation has been made. To date, the results from this installation are unsatisfactory.

Septic tanks are retention tanks to permit sewage solids to settle and anaerobic processes to convert sewage organics into harmless forms. Septic tanks are quite common in rural and suburban land areas not served by sewers. They also are sometimes used aboard vessels to treat sewage.

Data are not available on the quality of effluents from septic tanks installed aboard vessels. When operated ashore under near ideal conditions - 4.5 day retention time, 60°F. operating temperature - the effluent from a septic tank may have the following characteristics: BOD - 75 mg/l - 52% reduction; suspended solids 30 mg/l - 85% reduction; coliform bacteria before disinfection, mpn 0.72 x 106 - 97% reduction. Shorter retention times will reduce the effectiveness of the process and post chlorination will effectively disinfect the effluent.

Septic tanks in land-based use usually drain into a leach bed where the clarified sewage leaches through the soil, causing the bacteria to die before the water returns to the watercourses. When used aboard vessels, disinfection of the effluent is necessary.

The macerator-chlorinator is a mechanical device for grinding or macerating toilet wastes and adding a disinfection agent. The maximum particle size of the macerated sewage is in the range of one to five millimeters. Disinfection chemicals, usually a hypochlorite solution, are added to disinfect the sewage. Contact time between the disinfection agent and the sewage may vary from less than a minute to many hours, depending on the design of the unit and the rate of use.

At least four domestic corporations manufacture one or more proprietary designs of this type equipment. Differences in proprietary designs are such that some units are essentially automatic while others require manual control of the operational cycles.

As they are normally operated, macerator-chlorinator units do not reduce the BOD or suspended solids content of sewage before it is discharged. The particle size of the macerated sewage is usually such that it may be identified, and its discharge in close proximity to contact water sports would be esthetically offensive.

Under optimum conditions, macerator-chlorinator units may achieve the substantially complete kill of coliform bacteria; however, the short contact time between disinfectant and sewage leaves unanswered questions where less easily killed pathogens are concerned. Under less than optimum conditions, disinfection may become erratic. The quantity of hypochlorite required per toilet usage may vary from 200 to 500 ml, depending on solution strength. A residual available chlorine content in the range of 100 mg/l is required for satisfactory coliform reduction.

Macerator-chlorinators are relatively small in size and light in weight. These features may permit them to be installed in existing vessels where size and weight restrictions limit the utilization of other equipment.

The selection and installation of on-board sewage treatment or handling systems is a complex process involving many factors. Some of these factors relate to aspects of naval engineering and others to a vessel's mission or the use to which it is put.

Equipment weight and space requirements can be, and frequently are, critical considerations of marine engineering. A vessel hull of a particular size and type can support only a finite amount of weight and provide only a finite volume of usable space. These limited capabilities must be apportioned among various required equipment and vessel function requirements. During the design stage of a vessel, allowance for the space and weight needed for sewage treatment and suitable piping arrangements may be made with a minimum of dislocation of other functions.

Adding sewage treatment equipment to or retrofitting existing vessels may cause more serious and costly problems. Piping must be re-arranged to flow sewage to the control treatment point rather than be piped expeditiously out through the hull. The space and weight requirements of certain types of sewage treatment devices are so substantial that the functional utility of certain special purpose vessels could be reduced by their installation.

The mission served by a vessel has a considerable influence on the selection of on-board sewage handling equipment. Vessels which frequent restricted discharge areas must necessarily be equipped to hold wastes while in the restricted areas. Vessels can utilize holding tanks effectively if their mission brings them into frequent contact with service and supply areas which are equipped to service sewage holding tanks. Vessels may require systems which adequately treat and discharge sewage to the waters of the United States when their mission prevents them from making frequent contact with service and supply areas.

Special consideration should be given to vessels engaged in foreign commerce. These ocean-going vessels spend only a small fraction of each voyage in waters of the United States.

The American Flag vessels constitute only about 20 percent of the foreign commerce fleet which calls at American ports and competition in foreign commerce shipping is intense. Requiring the installation of on-board sewage treatment for the American Flag vessels could adversely affect their competitive position while correcting only a small fraction of the pollution from vessels engaged in foreign commerce. A more workable solution would seem to consist of modest holding tanks on board these vessels combined with shoreside connections for all vessels not equipped with secondary sewage treatment facilities during stays in port.

Problems associated with military-type vessels are discussed in conjunction with vessel pollution control programs of these agencies.

The use of on-board holding tanks and shoreside connections as a partial solution to water pollution from the operation of vessels is within the limitations of present day technology. Standard sizes and types of fittings must be agreed upon and installed so that any vessel could be serviced at any service point. But more importantly, shoreside facilities are not now generally available to service holding tank-shoreside connections. The holding tank-shoreside connection concept is not feasible until adequate service points are available. California has recognized this by requiring that holding tank and shoreside connection service facilities be installed in all docking facilities constructed using State funds.

Table VIII

Comparison Of The Pollution Prevention Potential

Of Vessel Sewage Treatment Systems

Treatment Device	BOD* Reduction	Sus. Solids Reduction	Bacteria Reduction	Degree of Treatment	System Vol. Cu. ft/person	System Wt. lbs./person
Holding Tank	100%	100%	100%	Ultimate	4-5 per day	250-900 per day
Incinerator	100%	100%	100%	Ultimate	nil	nil
Shoreside Connection	100%	100%	100%	Ultimate	nil	nil
Extended Aeration	90%	88%	99 + %	Secondary	7	450
Septic Tank	50%	85%	99 + %	Primary	30	1800
Macerator Chlorinator	None	None	99 + %	Disinfect-tion Only	nil	nil
"Over-the-Side"	None	None	None	None	None	None

* Biochemical oxygen demand

Exhibit 4
Page 6

POLLUTION CONTROL PROGRAMS

FWPCA Programs for Control of Pollution from the Operation of Vessels

The Federal Water Pollution Control Administration and its predecessor agency have been actively concerned with the problems of water pollution from the operation of vessels for many years. This concern has been evidenced by many FWPCA activities.

As the Division of Water Supply and Pollution Control of the Public Health Service, the FWPCA participated with other Federal Government agencies in the Interagency Committee on Sewage and Waste Disposal from Vessels. This Committee held five meetings from May 1960 to February 1964. The Committee was principally concerned with the protection of public health from vessel sewage discharges. One product of note from the Committee was a proposal to amend the Interstate Quarantine Regulations to require sewage treatment aboard vessels subject to these regulations. Even though this recommendation has not been formally adopted, it is a pioneering effort which has been widely circulated and is the basis for much present-day thinking on on-board sewage treatment.

Beginning in 1963, the FWPCA, then the Division of WS&PC, established the Office of Boat and Marina Sanitation. This office has exhibited at many marina and boating shows, pointing out the need for clean water and disseminating information to the recreational watercraft public. Working through State officials and interested industry groups, this office promoted the establishment of uniform State Laws regarding sewage from recreational watercraft. Additional efforts have been made to work with and encourage manufacturers of sewage treatment equipment to develop more usable and efficient sewage treatment devices.

Limited studies of the extent and nature of vessel pollution have been made as a part of several FWPCA projects. More or less detailed studies and estimates of pollution from vessels in Lake Mead, in Nevada-Colorado; Lake Michigan; Raritan Bay, New Jersey and New York; San Francisco Harbor, San Diego Bay and the Chesapeake Bay, to note a few. Some of these studies developed statistical information and estimates, while others collected chemical and bacteriological data. All of these studies indicate that vessels do, or have the capacity to, pollute the waters in which they are operated. An interesting example of this point is made on the Great Lakes. Statistical studies there indicate that, on the average, pollution from vessels constitutes less than 1 percent of the total pollution flowing into the lakes, yet during periods of maximum vessel use, pollution from this source increases to about 10 percent of the total.

Beginning early in 1968, a project was initiated in conjunction with the U.S. Coast Guard to determine maintenance operability and cost data on certain commercially available macerator-chlorinator units.

It was presumed, on the basis of previous short-term tests, that these units were dependable and effective when operating normally. On this basis, 19 units were purchased by FWPCA and scheduled for installation aboard 17 U.S. Coast Guard vessels (two vessels required two macerator-chlorinators each) operating in the New York and Great Lakes areas. Performance tests on the first unit revealed design inadequacies in addition to a number of relatively minor mechanical difficulties which are common in new equipment installations. The manufacturer is developing modifications to correct the difficulty.

The FWPCA regional laboratory in Corvallis, Oregon, is also involved in investigations of vessel pollution. A technical assistance project is underway to develop adequate means of collecting and treating sewage from houseboats and floating boathouses on the Willamette and Columbia Rivers. The State of Oregon requested this assistance so that the 450 + houseboats moored on the State's rivers, remote from sewers, can comply with the States' new law prohibiting the discharge of untreated or improperly treated sewage.

The FWPCA's most recent project on vessel pollution also is under the direction of the Corvallis laboratory. This project is a study of water quality and the effects of vessel pollution in San Diego Bay. The San Diego Bay Study was initiated during the second quarter of Calendar year 1966 and even though it is just now becoming fully operational, initial data collected by the project indicate a good correlation between pollution and anchored vessels. It is planned to determine the effects of vessel wastes on the waters of the Bay over a period of 18 months. San Diego Bay is a large naval base, and has large recreational watercraft and fishing fleets. During recent years, all domestic sewage has been diverted from the Bay and is now receiving proper treatment and disinfection so that vessel wastes now represent the principal source of pollution.

Control of Water Pollution from U.S. Coast Guard Vessels

The Coast Guard initiated a program for control of water pollution from its vessels in 1962 by establishing a project in the Testing and Development Division to develop a system for treating and disposing of sewage. The initial phases of this program dealt with installation of macerator-chlorinator units in hand pump sanitary systems. Since then, macerator-chlorinator units have been installed in pressure-operated systems, on small vessels, and large aerobic units are being evaluated on larger vessels.

As a result of this program, some provision for treatment to prevent water pollution is being made on new construction, and retrofitting is taking place on some older vessels. All new vessels of approximately 100 feet in length or less are equipped with macerator-chlorinator units. Larger vessels are designed with moderate sized holding tanks from which the sewage can be pumped directly over the side when at sea or can be pumped to sewage systems ashore through deck connections.

Also, since the sanitary drains are piped to collection tanks, future installation of treatment units can be relatively easily installed, when reliable units of a practical size have been developed. One of the vessels under construction, the RESOLUTE, 210 feet in length and with an authorized complement of 60 men, is equipped with an aerobic treatment plant. Evaluation of this plant will commence early in Calendar Year 1967.

The Coast Guard is operating approximately 400 boats and vessels equipped with sewage waste-producing facilities. Of these, about 100 are equipped with sewage treatment devices. Of these, 2 are experimental aerobic plants; 8 are pressure operated macerator-chlorinator units, and the remainder are hand pump macerator-chlorinator units.

The Coast Guard is an active partner with FWPCA in the testing of 19 macerator-chlorinator units.

Further installations on Coast Guard vessels will be governed by several factors. Most of the installations to date have been on small vessels and are relatively inexpensive units that meet generally accepted standards regarding health hazards and esthetic criteria. The remaining vessels to be equipped will require much larger and more sophisticated units. It is estimated that the cost of retrofitting these vessels will be in excess of $4,000,000. It is essential, therefore, that the minimal acceptable standards for sewage treatment be established before a program of this scope is continued. Additionally, further progress must be made in the development of treatment plants of a practical size and weight for shipboard installations. Also, such plants must be thoroughly tested with regard to efficiency, reliability, and maintainability.

Retrofitting older vessels is difficult. Available space is at a premium, and additional weight is, in many cases, intolerable. Rerouting of sanitary systems will be costly as well as undesirable from the standpoint of damage control. The ultimate solution for these vessels may well be in the installation of holding tanks and pumps for transfer to dockside connections or barges. Dockside sewer connections are practically nonexistent today, and this poses a particular problem for the Coast Guard, since many piers used by Coast Guard vessels are leased rather than Coast Guard owned.

As an early step in the U.S. Coast Guard's sewage treatment development program, two commercially available macerator-chlorinator type sewage treatment plants were procured from the manufacturer for test and evaluation. The plant consists of a control panel, holding tank-macerator, disinfecting agent, injection pump, and storage tank. This system is designed to operate automatically with pressure operated sanitary systems. It is primarily an enlarged version of the smaller macerator-chlorinator units which have been successfully used with the hand pump sanitary systems on small boats.

The principle of operation is primarily one of macerating the sewage to reduce particle size to facilitate disinfection and the introduction of a disinfection agent, i.e., a hypochlorite solution. These units have been installed and are currently undergoing evaluation.

To date, it would appear these units are satisfactory for a small ship equipped with a pressure operated sanitary system with a limited number of facilities, and for larger ships where only one or two facilities are to be connected to the treatment system. They are to be further evaluated and tested. In particular, it is desired to determine expected life of the various components and the minimum treatment necessary to produce a satisfactory effluent.

The two larger aerobic biological sewage treatment plants which were procured for an evaluation of this type of sewage treatment on ships have been installed on 180 foot buoy tenders. One was installed on the CGC SASSAFRAS. These were prototype units developed by the manufacturers for shipboard installation. While both were of the aerobic biological type treatment plant the means by which treatment is obtained is not the same. One depends primarily upon extended aeration, while the other uses aeration followed by a trickling filter stage to obtain the aerobic action. The primary purpose of these installations was to determine the feasibility of operation in a shipboard environment; in particular, the effect of agitation due to ship motion upon the aeration and settling tanks and flow rates and the effect of salt water being used as a flushing medium on the aeration and trickling filter treatment. The installation on the SASSAFRAS has been operated with only a few minor mechanical problems. Preliminary evaluations have been completed on both aerobic treatment units and neither is satisfactory. While the installation on the SASSAFRAS has been mechanically satisfactory, it has not achieved the BOD and suspended solids reduction which would be expected from this equipment. The other was a trickling filter system installed aboard the CGC SWEETGUM. This one has not been operating satisfactorily as the result of mechanical and design problems. It has been recommended that this unit be removed unless the manufacturer makes proper correction of the equipment.

Practically speaking, the weight and space requirements of the aerobic biological plants currently installed are excessive and severely limit their potential utilization in a shipboard environment. In an attempt to develop alternate solutions to the problem of treating shipboard sewage, two developmental projects have been established at the Coast Guard Field Testing and Development Center.

One project is testing a centrifuge-chlorination sewage treatment system. The principle of this system is to pass the raw sewage through a centrifuge, producing a dry cake which could be incinerated and a liquid containing dissolved solids and solids in colloidal suspension which could be chlorinated and discharged overboard. The advantage of this system over the macerator-chlorinator is that by removing and incinerating the syspended solids, approximately a 50% reduction in the bio-chemical oxygen demand can be obtained.

In addition, the effluent from the centrifuge will contain only solids of micron size and the utilization of chlorine should be significantly improved, thereby reducing the amount required.

The second project is evaluating an aerobic biological plant which is based upon extended aeration. This plant differs in concept from those previously evaluated in that aeration is obtained through the process of aspiration rather than bubbling compressed air through the liquid sewage in an aeration tank. Initially the aspiration method indicates that much smaller bubble size is obtained and a greater portion of the oxygen used to satisfy the oxygen demand of the waste than is the case with the diffused air systems. This results in a more compact package since the aeration tank may be reduced in size without loss of efficiency.

In both of these projects, the prototype plants are to be set up as a dockside facility. If either concept proves satisfactory, the plants will be modified to permit shipboard installation and will be installed for operational evaluation in a shipboard environment. Present planning calls for the completion of the dockside testing early in Calendar year 1967.

U.S. Navy Program for Shipboard Waste Disposal

Executive Order 11288 for the Prevention, Control, and Abatement of Water Pollution by Federal Activities clearly indicates that the traditional practice of discharging shipboard wastes directly overboard must be discontinued. The Navy's program for correcting this unsatisfactory practice is outlined briefly below.

Representatives from the Navy's Bureau of Ships and Bureau of Medicine and Surgery participated in an interagency committee convened by the U.S. Public Health Service to explore the problem of shipboard wastes from ships and to develop uniform treatment standards. Establishment of such standards is important to prevent ships from being subjected to numerous local standards depending upon their routes and ports of call. The major result of the committee's activities was the development of the proposed amendment to the Interstate Quarantine Regulations. The principal features of this proposal are set forth in Exhibit VI.

To fully understand the impact of these proposed requirements on ship design, a brief review of conventional naval shipboard sewage systems and the peculiarities of shipboard plumbing is in order.

Except in a small number of cases, all waste drainage systems are gravity systems discharging directly overboard with minimum internal piping. There are a number of reasons for utilizing this design concept such as weight and space conservation, minimum leak and stoppage risk and damage control consideration. This concept does impose on the naval architect space allocation restrictions in keeping sanitary facilities sufficiently above the waterline to permit gravity drainage.

Since modern naval warships must be designed to sustain prescribed damage and maintain mission capabilities, the damage control features of all systems are important design consideration. Drainage systems are no exception. Therefore, it is essential that penetrations of watertight decks be kept to a minimum and main watertight bulkheads never be penetrated. This design philosophy has led to a waste drainage system for each main watertight subdivision and, in many instances, separate systems within main subdivisions.

In developing a program to provide a satisfactory solution to the naval shipboard sewage disposal problem, existing shipboard sewage treatment systems were evaluated. The system that has found the most widespread acceptance in commercial shipbuilding circles is the extended aeration, activated sludge process. The fundamental feature of the unit is a system of continuous aeration of the organic material in an aeration chamber with no other sludge digestion required. Some gains in space and weight reduction have been realized by increasing the air volumes and thus decreasing total processing time. Despite these efforts, the space and weight characteristics of this system make it unattractive for naval shipboard use. To illustrate this, the following compares the space-weight relationships for two ship types:

	Guided Missile Frigate	Aircraft Carrier
Treatment Units Required	4	22
Deck Area (FT^2)	550	4500
Weight (Tons)	30	250

In addition to the adverse penalties imposed on the ship, operating experience has indicated that treatment efficiency has been marginal and sludge holding facilities are not being recommended.

In the absence of factual data on ship sewage characteristics and treatment hardware adaptable to naval ship use, Naval Ship Systems Command (NAVSHIPS) undertook a comprehensive research and development program. The first phase of this program was a waste survey in representative areas in each of four different type ships.

The U.S. Navy Marine Engineering Laboratory, Annapolis, Maryland, conducted this survey and findings are reported in "U.S. Navy Marine Engineering Laboratory Research and Development Report 346/64, January 1965."

With the results of the waste survey used as a characteristic influent and the proposed effluent standards of the interagency committee used as the treatment goal, NAVSHIPS contacted industry to develop the required system hardware.

Formal request for proposals (RFP) for this research and development effort was advertised in September 1965.

Several technical requirements unique to the shipboard environment were included in the RFP:

(1) The system should be capable of intermittent operation for relatively short-time intervals and should be capable of being secured for long periods of time without degrading treatment efficiency. Means must be provided for by-passing the treatment system to discharge raw sewage overboard while the ship is at sea and the treatment system secured.

(2) The physical and chemical characteristics of shipboard sewage are subject to variation depending on the flushing water. The system should be capable of meeting the effluent standards while transiting or lying in sea water, fresh water, or mixture thereof.

(3) Careful attention should be given to minimizing system size and weight. Overall system height including withdrawal clearance for removal of components should not exceed six feet.

(4) The system should meet all standard Navy environmental requirements including ability to operate satisfactorily at extreme temperatures, permanent list or trim and specified amounts of pitch and roll.

Eleven proposals representing an excellent cross section of industrial competence were received in response to the RFP. Assistance during the evaluation period was provided by the Federal Water Pollution Control Administration and the U.S. Public Health Service. A three phase contract was awarded in May 1966. Phase I established system feasibility by means of a laboratory model and has been approved. Phase II is scheduled for completion in April 1967 with the delivery of a full scale prototype for laboratory evaluation. Installation of the Phase III unit aboard a destroyer is scheduled for late 1967. Space and weight reservations on all new ship designs where the complement is 40 or more are being made for future installation of this unit. In addition, detailed cost and feasibility studies are being conducted for the installation of the system on existing ships.

Paralleling the large treatment system development program, the Navy has also been evaluating commercially available macerator-chlorinator type units which will meet the above mentioned proposed standards for small ships and craft. This work was done by the U.S. Navy Marine Engineering Laboratory and is reported in the "U.S. Navy Marine Engineering Laboratory Evaluation Report 104/66, March 1966." Installation of such units is planned for small ships and craft in the Navy's future shipbuilding programs. Performance requirements for these units are specified in Military Specification MIL-S-24201. In addition, plans are being formulated to backfit sewage treatment plants in existing ships on a phased basis.

In summary, it is the policy of the Secretary of the Navy that a maximum effort be made to incorporate environmental pollution preventive measures in the basic design of all ships, and that the Navy will cooperate fully with the Federal Water Pollution Control Administration and the Department of Health, Education, and Welfare to comply with published standards and criteria relating to pollution abatement by Federal Activities.

Control of Water Pollution from Corps of Engineers Civil Works Vessels

The Corps of Engineers Civil Works has installed or scheduled installation of sewage treatment systems on all Corps of Engineers-owned vessels which have installed sanitary facilities. A total of 255 treatment installations have been made or are scheduled for completion in early 1967. An additional 66 installations are programmed for installation in Corps of Engineers' vessels by early 1970. When the programmed installations are completed, all Corps of Engineers-owned vessels will be equipped with sewage treatment systems.

Engineers Regulation No. 1125-2-302, dated 28 October 1965, describes the policies and procedures covering the design, acquisition, installation, operation and testing of sewage disposal equipment on all Civil Works-owned floating plants.

The above regulation was based on the Federal Water Pollution Control Act (33 USC 466 et seq.), along with the policies of the Department of Health, Education, and Welfare, at the time of the writing and requires the following:

1. An aerobic type system for vessels with a total normal passenger crew complement of 25 or more.

2. A central maceration-chlorination type system for a normal passenger and crew complement of between 10 and 24.

3. Individually packaged maceration-chlorination, electrochemical, or other approved (by ENGCW-OS) types shall be used when crew complement is between 1 and 9.

Control criteria, sampling and testing procedures are based on advice and guidance received from the Office of the Surgeon General, U.S. Army, and the Department of Health, Education and Welfare.

The Corps of Engineers Civil Works has not programmed or accomplished tests or experiments in connection with water pollution. Advice and guidance from the U.S. Army Surgeon general's Office, the Department of Health, Education, and Welfare, the U.S. Navy, Federal Water Pollution Control Administration and private industry has been utilized.

Department of Commerce Activity on the Prevention of Water Pollution

The Maritime Administration, Department of Commerce, has long been generally concerned with the extent to which the waters and coastlines of the United States are being polluted. It is specifically concerned when this pollution is attributed to ships of the United States.

The concern of this agency is expressed in several ways. First by participation in organizations whose charter and goal are to reduce or eliminate this menace wherever pollution is found. In this regard, the deliberations of the National Committee for the Prevention of Pollution of the Seas by Oil, led by the Commandant of the United States Coast Guard, are heartily supported by active participation in the work of the committee. The Maritime Administration has participated in the progressive work of this group since its inception, and, upon request of the group, furnished an advisor for the International Conference on the Prevention of Pollution of the Seas by Oil, London, 1962. This resulted in revising and updating the 1954 Convention, and the ultimate ratification of the 1954 Convention; also the introduction of implementing legislation to permit the work of the Conference to be fully effective in this country.

During deliberations of the 1962 Conference the Maritime Administration representative as well as other members of the United States Delegation to the Conference, specifically supported Resolutions 8, 12 and 13 of the final Act of 1962.

These resolutions obligate the signatories to the Act to (1) encourage the development and installation of efficient oil-water separators for use in ships and the preparation of an international performance specification for such separators (Resolution 8); (2) continue research on prevention of oil pollution (Resolution 12); and (3) encourage the exchange of information among countries for the coordination of research (Resolution 13).

In accordance with the aims and objectives of the Inter-Governmental Maritime Consultative Organization in regard to these specific items, and in accordance with these United States commitments to the International Convention for the Prevention of Pollution of the Seas by Oil, London, 1954, as amended and ratified, 1962, the Maritime Administration has expressed its concern in a second specific way by actively sponsoring research to this end; i. e., prevention of pollution of water.

To date, this program has consisted of a contract with the Pfaudler-Permutit Co., of Paramus, New Jersey, for the development of a marine oil-water separator employing the principle of static coalescence, and a contract awarded to ITT Research Institute, Chicago, Illinois, for the development of a rapid and automatic means of monitoring oil concentrations in water.

A research contract has been awarded to the CUNO Engineering Corp., Meriden, Conn., for the development of a compact, low-cost marine type oil-water separation system. This work is being carried out in order to provide to ship operators a means of meeting the requirements of the International Convention on Prevention of Pollution of the Seas by Oil, which forbids the discharge in certain areas of persistent oil and oily residues.

The dynamic system using standard proprietary equipment proposed by CUNO appears to offer promising results, which will meet current requirements of limiting overboard oil discharge in excess of 100 parts per million while at the same time significantly reducing the installed unit volume required. A phased effort is proposed which will require approximately 12 months at a total estimated cost of $64,000. The goal is development of a practical system which can be produced for commercial use.

Pursuant to its responsibility for the design and operation of ships, the Maritime Administration furnishes design and environmental criteria to private manufacturers of equipment, design agents, and shipyards or anyone else interested in designing, building or installing oil-water separator equipment or instruments pertaining thereto.

While the oil-water separator and oil content meter are companion projects, another separate but major area of interest is the problem of pollution of water by sewage and sanitary wastes from ships. This is a problem specifically affecting our vast Great Lakes waters, and our river and harbor areas.

Since the Maritime Administration is responsible for determining the suitability of ships and their appurtenances constructed in accordance with subsidy and ship replacement programs, its interest in all forms of pollution is obvious. In this regard Maritime Administration is requiring the installation of clean water ballast tanks in its new ship construction program.

The U.S. Coast and Geodetic Survey of the Department of Commerce also operates 22 vessels which have crew complements ranging from 9 to 83 persons. This number of vessels is so small that they are not listed in statistical summaries elsewhere in this report. The U.S. Coast and Geodetic Survey vessel pollution control program is worthy of note in that all 22 of its vessels have installed sewage treatment devices to meet the short term goal requirements herein developed.

LAWS AND REGULATIONS DIRECTLY APPLICABLE TO VESSEL WASTE DISPOSAL

The United States Congress has enacted laws which prohibit certain discharges of refuse and oil from vessels into navigable, or coastal navigable waters of the United States. Regulations adopted pursuant to the provisions of other laws prohibit the discharge of sewage and ballast and bilge waters from vessels near domestic water intakes in the Great Lakes and prohibit garbage containing meats of foreign origin or garbage arriving in the United States aboard any conveyance from being discharged into United States waters. The salient provisions of these laws and regulations can be briefly summarized.

The New York Harbor Act of 1888 (33USC 441-451b) applies to the harbors of New York, Hampton Roads and Baltimore. It prohibits the discharge or deposit of refuse, dirt, ashes, cinders, etc., or any other matters of any kind except that flowing from streets and sewers in a liquid state in the waters of the harbors. Administration of this Act is under the U. S. Corps of Engineers.

The Refuse Act of 1899 (33USC 407-409, 411, 419) makes it unlawful to dump refuse matter of any kind, other than that flowing from sewers in a liquid state, from any vessel into navigable waters of the United States whereby navigation may be impeded or obstructed. This Act has also been interpreted by U. S. authorities to prohibit the discharge of oil and oily wastes. Administration of this Act is under the U. S. Corps of Engineers. This Act is usually considered to be a protection for navigation rather than a prevention of littering and water pollution.

The Oil Pollution Act of 1924 (33USC 431-437) prohibits the discharge of oil into or upon the coastal navigable waters from any vessel, except under certain emergency conditions, using fuel oil as fuel for the generation of propulsion power or any vessel carrying or having oil thereon in excess of that necessary for its lubricating requirements.

The Clean Water Restoration Act of 1966, Section 211, extends protection from oil pollution to all navigable waters of the United States and places administration of the Oil Pollution Act of 1924 under the Secretary of the Interior with assistance from the U. S. Coast Guard and U. S. Corps of Engineers.

The Oil Pollution Act of 1961 (33USC 1001-1015) implements the provisions of the International Convention for the Prevention of the Pollution of the Sea by Oil, 1954. This international convention restricts the discharge of oily wastes within certain international waters. Reservations in the Convention permit U. S. statutes to apply in U. S. territorial waters.

The Federal Water Pollution Control Act (33USC 466-466K), as amended, places basic responsibility for water pollution control in the Federal Water Pollution Control Administration. Water quality standards promulgated pursuant to the provisions of the 1965 amendment (Water Quality Act of 1965) will apply to all sources of pollution including vessels and may restrict the discharge of pollutants from vessels in the waters subject to these standards.

The Interstate Quarantine Regulations of the Public Health Service (42 CFR 72.121) restrict the discharge of sewage, ballast or bilge water from all vessels within a radius of three miles (generally) from specified potable water intakes in the Great Lakes. Extension of this protection to all potable waters intakes is under consideration.

Proposed amendments to the Interstate Quarantine Regulations would require all new vessels or vessels undergoing major conversion to be equipped with facilities to treat or retain wastes. These proposals would require:

(1) For vessels with a normal complement (passengers and crew) of 41 or more, minimum treatment should be such as to produce an effluent, without the benefit of dilution with water in addition to that required for the normal operation of contributing sanitary fixtures, with 50 mg/l or less of Biochemical Oxygen Demand (BOD), 150 mg/l or less of suspended solids, and 1,000 or less coliform bacteria per 100 ml. Facilities should be provided for the storage of excess sludge for proper ultimate disposal.

(2) For vessels with a normal complement (passengers and crew) of 40 or less, minimum treatment should consist of passing the wastes through a grinder followed by disinfection which will produce an effluent having 1,000 or less coliforms per 100 ml. without benefit of dilution with water in addition to that required for the normal operation of the contributing sanitary fixtures.

Federal Regulations, 9 CFR Sec. 94.5, prohibit the discharge of garbage containing meats of foreign origin into any territorial waters of the United States. Also, Federal Regulations, 7 CFR 330.400, require that garbage from any conveyance arriving in the United States must be disposed of in such manner as to prevent dissemination of plant pests. To comply with these regulations, all garbage must be retained aboard until it may be unloaded in port for incineration or other method of disposal as may apply to the ports visited.

Garbage should be stored aboard in sound, liquid-proof containers with tight-fitting lids. Storage containers should be of such size that they may easily be handled. Thirty gallon metal or plastic cans are recommended. The number of cans on board each vessel should be sufficient to hold all garbage which may be accumulated between ports of call. Canvas chutes tied at the bottom and similar containers which are installed for sea dumping of garbage are not permitted.

The Saint Lawrence Seaway Development Corporation Regulations (33CFR 401, 401.17 & 401.21) prohibit the discharge of sewage and other wastes from vessels within the immediate vicinity of corporation installations.

State laws and regulations specifically controlling sewage discharges from vessels vary widely. There has been considerable discussion and effort on the part of interested boating organizations for the development of uniform state laws regulating the discharge of waste from boats. The need for uniform regulation is apparent when the mobility of recreational watercraft is considered. Not only do boats sail from one state to another, but overland transport via trailer makes the recreational watercraft fleet extremely mobile.

Despite pressure for uniform state laws, there is a wide range of requirements and permissible equipment among the states. In Table IX, 50 states have been considered. Of these, 22 states do not regulate discharges from boats or vessels while the other 28 have laws or regulations. Twelve states prohibit the discharge of sewage from boats, requiring the toilet discharge to be sealed. Eighteen states approve or prefer holding tanks; 11 approve incinerators; 11 approve disinfection and 2 states accept disinfection. Five states require approved treatment devices but have not implemented this requirement by approving specific devices.

From this summary, and the summary of boat registration laws presented elsewhere in this report, the prospect of uniform state laws regulating waste discharges from boats and vessels appears remote. Yet such uniform regulations, with attendant equipment testing and approval, are needed both for water pollution control and to facilitate interstate travel and the full enjoyment of watercraft recreation.

The regulation and control of litter or refuse from vessels and boats have been almost entirely a prerogative of the states. Their laws and regulations vary widely and surveillance and enforcement is equally varied. This problem is similar in many respects to highway littering and will require both cooperation from vessel operators and ubiquitous enforcement activities to achieve its correction.

Under the requirements of Section 17 of the Clean Water Restoration Act of 1966, the laws and regulations applying to all waste discharges and litter from all boats and vessels operating or capable of operating on interstate waters will be studied fully with a view to recommending Federal legislation which would require enforceable pollution prevention measures.

Table IX

Summary of State Laws & Regulations Relating Specifically to Vessel Waste Disposal

STATE	State Law or Regulation		Approved Sewage System					
	NO	YES	No Discharge	Holding Tank	Incinerator	Disinfection*	Not Specified	
Alabama	X							
Alaska		X						
Arizona		X	X		X		X	
Arkansas		X		X	X	X		
California		X	X	X	X			
Colorado		X	X	X				
Connecticut		X	X					
Delaware	X							
Florida	X							
Georgia		X				X		
Hawaii		X				X		
Idaho	X A							
Illinois		X					X	
Indiana		X	X	X				
Iowa	X							
Kansas	X					P		
Kentucky	X							
Louisiana	X A			P	P			
Maine	X					P		
Maryland	X							
Massachusetts	X			P				
Michigan		X	X					
Minnesota		X		X	X	X		
Mississippi	X			P	P			
Missouri		X		X	X	X		
Montana		X	X	X				
Nebraska		X					X	
Nevada		X					X	
New Hampshire		X		X	X	X		
New Jersey		X	X					

Table IX cont.

Summary of State Laws & Regulations
Relating Specifically to Vessel Waste Disposal

STATE	State Law or Regulation		Approved Sewage System					
	NO	YES						
New Mexico	X							
New York		X				X		
North Carolina		X		X	X	X		
North Dakota	X							
Ohio		X	X	X				
Oklahoma		X					X	
Oregon		X	X	X				
Pennsylvania	X A							
Rhode Island	X							
South Carolina	X							
South Dakota		X				X		
Tennessee		X		X	X	X		
Texas		X	X	X				
Utah	X							
Vermont		X		X		X		
Virginia	X							
Washington	X							
West Virginia	X							
Wisconsin		X	X	X	X			
Wyoming	X							
TOTAL	22	28	12	18	11	13	5	

Notes: A - Vessel pollution may be included under general Water Pollution Control Act.

P - Device is accepted or preferred by State.

\# - Usually macerator-chlorinator type device.

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